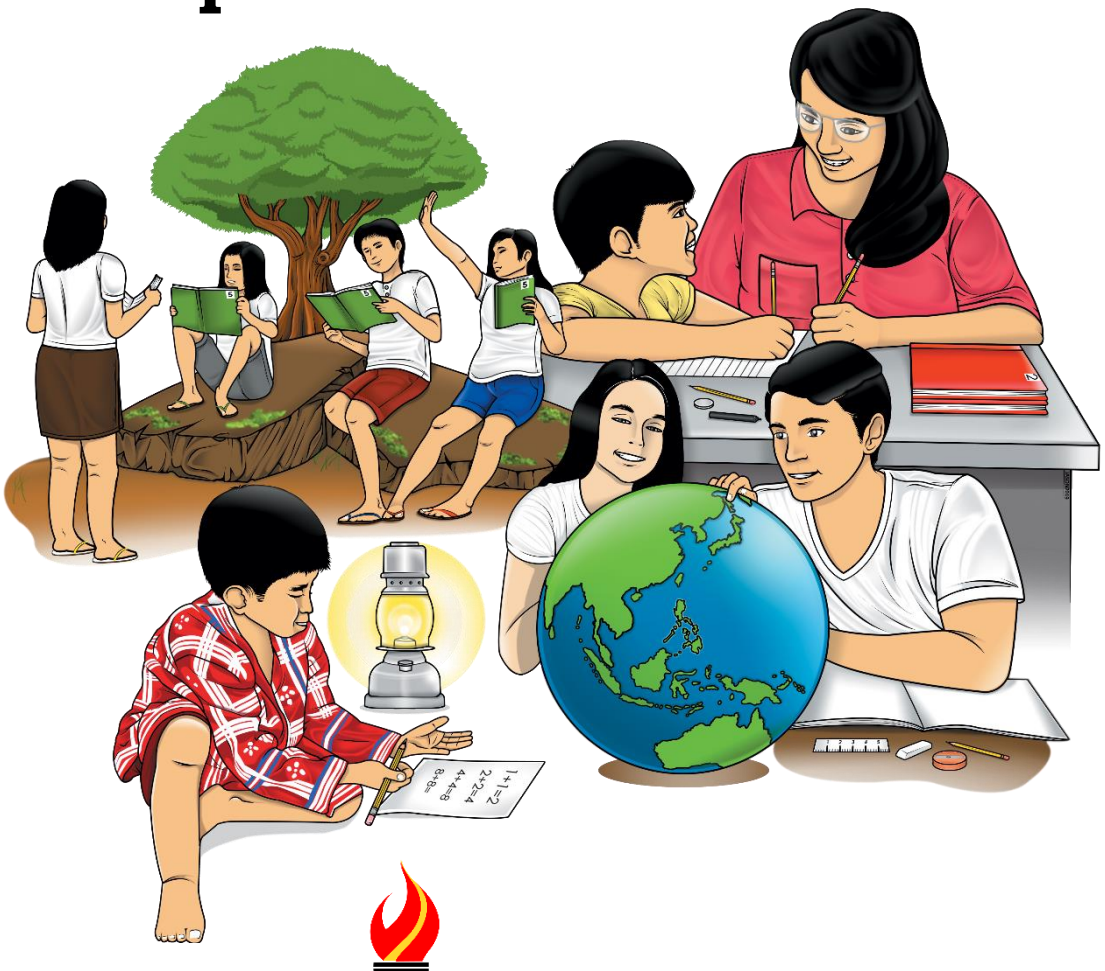
9

DepED
DEPARTMENT OF EDUCATION

Science

Quarter 4 - Module 3:
Impulse and Momentum



ALTERNATIVE DELIVERY MODE
ADM

Science- Grade 9
Alternative Delivery Mode
Quarter 4 - Module 3: Impulse and Momentum
First Edition, 2020

Published by the Department of Education
Secretary: Leonor Magtolis Briones
Undersecretary: Diosdado M. San Antonio

Development Team of the Module

Authors: Cherry Mae P. Nogalo
Michelle M. Quinga

Reviewers: Richard S. Talaid
Fe Nijaga
Jeremy P. Sacon
Nancy B. Pelare
Janice Corpuz

Illustrator and Layout Artist: Chris T. Sagarino
May D. Arapoc
Ana Lorma A. Dahiroc
Cherry Mae P. Nogalo
Michelle M. Quinga

Management Team

Chairperson: Roy Angelo E. Gazo, CESO V

Co-Chairpersons: Shambaeh A. Abantas-Usman

Members: Mala Epra B. Magnaong
Henry B. Abueva
Engr. Ann Q. Solijon
Rustico Y. Jerusalem
Meriam S. Otarra
Charlotte D. Quidlat

Printed in the Philippines by _____

Department of Education - Division of Iligan City
Office Address: General Aguinaldo, St., Iligan City
Telefax: (063)221-6069
E-mail Address: iligan.city@deped.gov.ph

9

Science

Quarter 4 - Module 3:
Impulse and Momentum

DepED
DEPARTMENT OF EDUCATION

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

Have you ever experience riding a motorcycle or a car on a muddy road? What do you observe about the speed of the motorcycle/car? Did it slow down or speeds up? Have you seen vehicular collisions in movies or even witness it in real life? In this lesson, we will know the science concepts behind it.

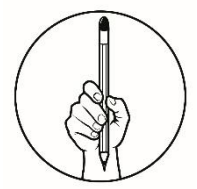
In this module, you will learn about the principles applied to collision of objects which includes the following lessons:

Lesson 1: Impulse and Momentum

Lesson 2: Relationship of Impulse and Momentum to Collisions of Objects

At the end of this module, you should be able to:

1. Relate impulse and momentum to collision of objects (e.g., vehicular collision); **(S9FE-IVb-36)**

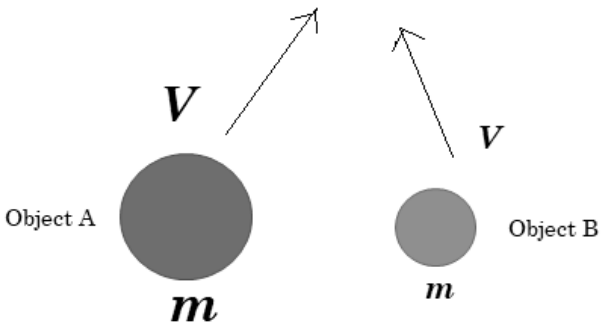


What I Know

TRUE/FALSE

Directions: Read each statement below carefully. Write **T** on the space before the number if you think a statement it **TRUE** and write **F**, if you think the statement is **FALSE**.

_____1. An object which is moving at a constant speed has momentum.
_____2. Two objects of different masses are moving at the same speed; the more massive object will have a greater momentum.
_____3. A less massive object can never have more momentum that a more massive object.
_____4. Two different objects are moving at the same speed. The larger object is more difficult to stop.
_____5. An object with varying speed will have varying momentum.
_____6. Objects involved in collisions encounter impulses.
_____7. Impulse is the force needed to produce a change in the body's momentum through a combination of changes in its mass and/or velocity
_____7. An object which experiences a net impulse will definitely experience a momentum change.
_____8. In a collision, the impulse experienced by an object is not equal to its momentum change.
_____9. Two cars with the same mass collided but they have different velocities. Car B travels faster than Car A. Therefore, Car A has greater momentum change than Car B.
_____10. Two objects collide. Object A has greater mass and velocity while Object B has smaller mass and velocity. In this case, Object A has greater change of momentum or impulse.



Lesson 1 Impulse and Momentum

What's In

In the previous topic, we talked about projectile motion. At this point, you already know how to describe the motions and the relationship of the components of a projectile. Suppose you play basketball with your friends. What will happen to the ball if it hits the board instead of inside the ring? How about if you bump into another player than is bigger than you? These questions will be answered as you go along with the module.

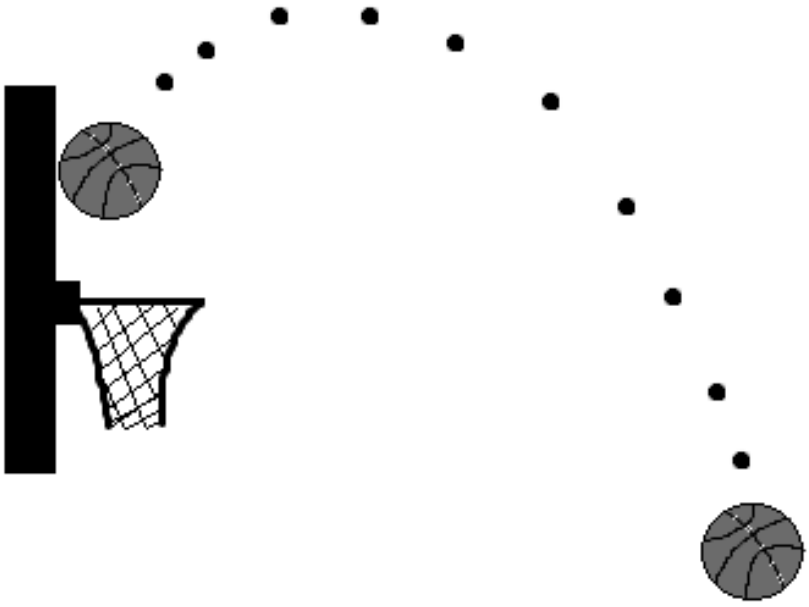


***Figure 1**. A typical trajectory of a basketball. Illustrated by Cherry Mae P. Nogalo.*

What's New

Instruction: Read the words in the WORD BOX. Can you find all the words hidden in the puzzle? Circle each word you find. You might find the words spelled across, down, and diagonally. The words might be spelled forward or backward.

F	A	T	I	M	E	R	M	I
O	D	E	M	H	V	G	A	S
R	U	Z	P	O	E	L	S	T
C	A	L	U	P	T	E	S	X
E	V	E	L	O	C	I	T	Y
N	O	I	S	I	L	L	O	C
M	O	M	E	N	T	U	M	N

Momentum	Impulse	Mass	Collision
Velocity	Motion	Time	Force

What is It

Momentum

One of the most common team sports is basketball. Imagine two teams who are involved in a really tight quarter finals tournament. Team A is 2 pts ahead of Team B. Later on in the match, a player from Team B scores a three-point shot and followed by a series of 2-point shots from the said team. Team B couldn't stop their momentum. What do you mean by Momentum? Write your own meaning on the given space below.

Momentum is _____.

In the example above, these are the things we need to consider in defining momentum:

a. the object has mass
b. the object is moving

Any moving object with a quantity of matter has momentum. Momentum simply means "mass in motion." It is equal to the product of mass and velocity.

Mathematically, it is expressed as

$$p = m \times v$$

where:

p is the momentum in kilogram · meter per second (kg · m/s)
m is the mass of the moving object in kilogram (kg)
v refers to velocity of the moving object in meter per second (m/s)

Given the information above, what is now the momentum of an object that is not moving? _____

If any object of any mass is not moving, it has **zero momentum** since its velocity is zero.

Let us first consider the situation below and try to answer the given questions.

Suppose you ride a bus from Iligan City to Cagayan de Oro City. What do you think will happen to the bus after if it passes along a curvy road?

a. The bus will slow down.
b. The bus will speed up or move faster.
c. The velocity of the bus will not change.

After passing a curvy road, the bus travels in a straight road. How will you describe the velocity of the bus?

a. it increases
b. it decreases
c. it does not change at all

There were only 25 passengers in the bus. Along the way, 5 passengers drop at Laguindingan bus stop, and another 4 passengers dropped-off at Opol bus stop. What can you say about the mass of the bus?

a. it increases
b. it decreases
c. it does not change at all

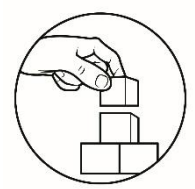
If your answered (a) the bus slows down on the first question and (a) it increases on the second, and (b) it decreases on the third question, then all your answers are correct.

Therefore, when the object slows down or moves faster, its velocity decreases or increases. If there is a change in the velocity or the mass of an object, there is also a change in momentum. That change of momentum is called *Impulse*.

Impulse = Change in Momentum

What do you think the impulse of an object moving with constant momentum?

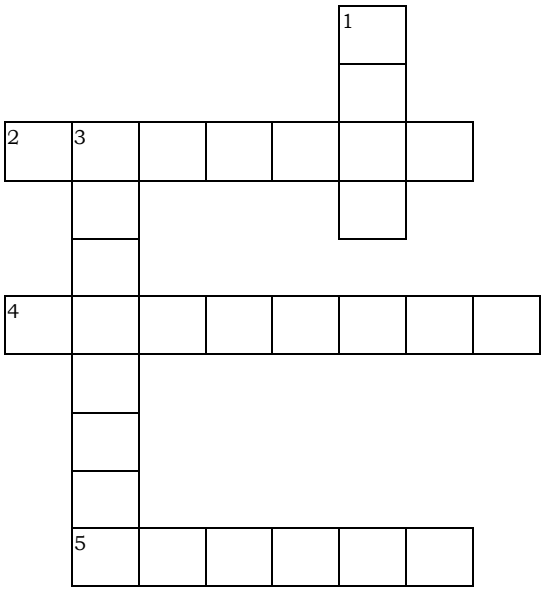
Constant means there is no change. Therefore, there is no impulse or zero impulse for objects moving with constant momentum.



What's More

A. Crossword Puzzle

Direction: Complete the crossword puzzle by filling out the correct words in the given clues. Place your answers into the puzzle by writing the letters in each box.



Across

2 change in momentum

4 the speed at which an object travels

5 being moved

Down

1 quantity of matter in an object

3 Equal to the product of mass and velocity

B. Read the following statements below. Check (/)the box before each number if you agree on statement and mark X on the box, if you disagree.

Suppose a car (the one pictured below) is travelling along a concrete road (A), curvy road (B), rough road (C) and cemented road (D).

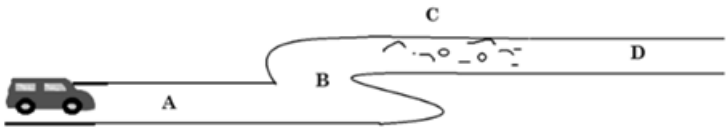


Figure 1.1. *Car travelling at different points. Illustrated by Cherry Mae P. Nogalo.*

☐ 1. At point A, the car increases its velocity. Then, there is a change in the momentum of the car.

☐ 2. At point B, the car should increase its velocity and to have less momentum.

☐ 3. There is no impulse when driving along point C.

☐ 4. If the car has constant velocity along point D and beyond, the car's impulse is zero.

What I Have Learned

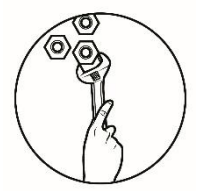
A. MULTIPLE CHOICE. Choose the letter of the best answer.

1. Which of following describes momentum?
   a. Mass times its velocity.
   b. Force times the time interval.
   c. Force times its acceleration.
   d. Mass times its acceleration.
2. Which of these is the quantity of matter in an object?
   a. force
   b. mass
   c. motion
   d. time

3. What is impulse?
    a. the change in volume of an object.
    b. the change in momentum of an object
    c. the original momentum of the object.
    d. a force applied to an object for a period of time.
4. Which of the following would describe momentum?
    a. $p=mv$
    b. $p=m/v$
    c. $p=v/t$
    d. $p=F/t$
5. What is the impulse of an object moving with constant momentum?
    a. 0
    b. 1
    c. the same with momentum
    d. none of these

B. Modified True or False. Write true on the space provided before the number if the statement is correct, but if it is false, change the underlined word or group of words to make the whole statement true.

_____1. A moving object has momentum.
_____2. When the object slows down, the velocity increases.
_____3. An object with zero velocity has zero momentum.
_____4. An object moving with constant momentum has impulse.
_____5. If there is no change in momentum, there would be no impulse.



What I Can Do

Enumerate at least 3 activities in real life situations which involves the concepts of momentum and impulse.

Example: Bird flying, driving a motorcycle along a muddy road

1. _____

   _____

2. _____

   _____

3. _____

   _____

Lesson 2 Relationship of Impulse and Momentum to Collision of Objects

At the end of the lesson, you will be able to ***determine the relationship of impulse and momentum to collision of objects.***

What's In

You know already that any moving object has momentum. It is equal to the product of mass and velocity. Impulse, on the other hand is a change in momentum of a moving object. What will happen to a moving object if it collides with another object?

What's New

Suppose you are playing billiard in which all the balls are of the same mass. The cue ball and Ball #1 are initially at rest. Then, you use the cue (long tapered stick or *tako*) to hit Ball #1. After the collision, Ball #1 had a greater velocity than the cue ball.

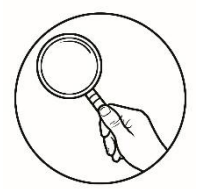
Figure 2.1. *Two billiard balls before and after collision. Illustrated by Cherry Mae P. Nogalo.*

Based on the given illustration, answer the following questions:

1. What did you observe on the mass of the cue ball before and after collision?
   _____
2. How about the mass of ball #1 before and after collision?
   _____
3. Since it is initially at rest, the initial velocity of the balls is _____.
4. After collision, is there a change in velocity of the cue ball? _____
5. After collision, is there a change in velocity of ball number 1? _____

From the given situation, is there a change in momentum after hitting ball # 1?

Let's find out.



What is It

In Lesson 1, you already learned that if there is a change in the velocity or the mass of an object, there is also a change in momentum.

Let us take a look on the illustration of the collision between the cue ball and Ball #1 once again (Figure 2.1) and answer the questions that follows.

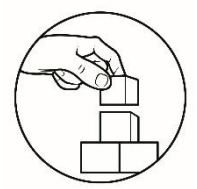
Figure 2.1. *Two billiard balls before and after collision. Illustrated by Cherry Mae P. Nogalo.*

1. Is there a change in momentum of the cue ball? _____
   Why? _____
   Then there is impulse
2. Is there a change in momentum of the Ball #1? _____
   Why? _____
   Then there is impulse
3. Which ball has a greater change in momentum: the cue ball or Ball #1?
   _____
4. Which ball has a greater impulse: the cue ball or Ball #1?
   _____

Since the cue ball and Ball #1 have a change in velocity after collision, then both balls have a change in momentum. The Ball #1 has a greater change of momentum because it has greater change in velocity.

In collisions, an object that experiences a greater change in momentum has a greater impulse.

Therefore, this shows the relationship between impulse and momentum, that a change in momentum is equal to impulse.



What's More

Read the following situations involving collisions and answer the questions that follows.

Situation 1: *Suppose that two cars with equal masses collide with each other. Car A travels faster than Car B. They both stopped after collision.*

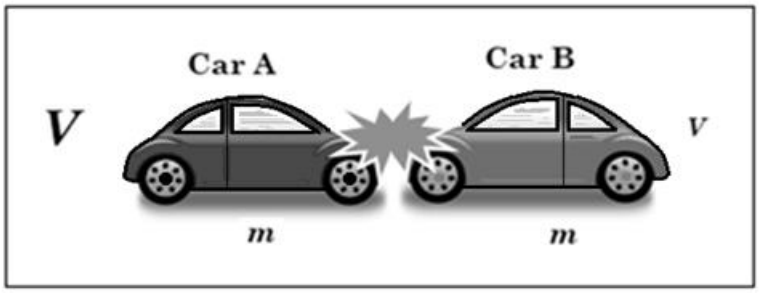


Figure 2.2. *Collision of two cars with equal masses. Illustrated by Cherry Mae P. Nogalo.*

a. Which of the two cars has the greatest change of velocity? _____

b. Which car has the greater change in momentum? Explain your answer.
_____
_____

c. Which car has the greater impulse? _____

In other words, the object that experience a greater impulse is the one that has the greater change in momentum.

Situation 2: *A basketball and ping pong ball collided having the same velocity but different mass.*

a. Which ball has a lesser momentum? _____
b. Which ball has a greater impulse? _____

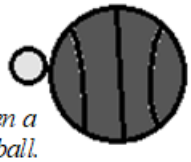


Figure 2.3. *Collision between a basketball and a ping pong ball. Illustrated by Michelle M. Quinga.*

Situation 3: *Two marbles collide. Marble A has greater mass and velocity while Marble B has smaller mass and velocity.*

a. Which has a greater momentum- marble A or B? _____
b. Which marble has a greater impulse? _____
c. Which marble would you think will be thrown away? _____
d. Why? _____

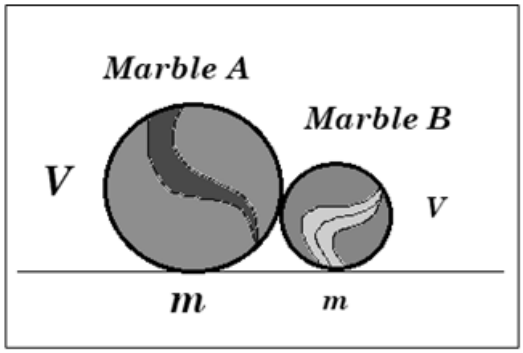


Figure 2.4. *Collision between two marbles with different masses. Illustrated by Cherry Mae P. Nogalo.*

What I Have Learned

MULTIPLE CHOICE: Read the following situation and choose the letter of the best answer.

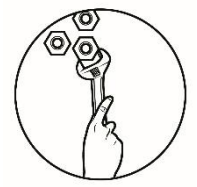
1. A mini dump truck full of abaca fiber collides with a motorcycle or *habal-habal*. The velocity of the truck and the motorcycle is the same. Which has a greater impulse? Why?

Figure 2.5. *A mini dump truck. Illustrated by Cherry Mae P. Nogalo.*

A. The mini dump truck because it has larger change in momentum.
B. The mini dump truck because it is full of abaca fiber.
C. The motorcycle because it has larger change in momentum.
D. The motorcycle because it has lesser mass.

2. A car collided with a bus that has greater mass and velocity than the car. Which of these describes the change of momentum of the bus and the car?
   A. The change of momentum of the bus is less than that of the car.
   B. The change of momentum of the bus is greater than that of the car.
   C. The change of momentum of the car and the bus is the same.
   D. The change of momentum of the car and the bus is zero.

3. Two marbles of equal mass are rolling towards each other. One is rolling at 7 m/sec and the other at 10 m/sec. The one rolling faster has a_____ momentum and _____ impulse. It will surely knock the other one backwards.
   A. lesser, lesser
   B. lesser, greater
   C. greater, lesser
   D. greater, greater



What I Can Do

Differentiated Activity: Impulse and Momentum

Direction: In this activity, you are going to choose only one (1) task that you can complete. After completing the task, submit it to your teacher. Please refer to the rubrics as your guide.

1. Write at least three stanzas of poem about relationship of impulse and momentum of collision of objects. Write it on a short bond paper. (Handwritten or printed)

RUBRICS for POEM WRITING (#1)

Criteria	Exemplary (5 pts.)	Accomplished (4 pts)	Developing (3 pts)	Beginning (2 pts)
Content	The poem contains the topic about the relationship of impulse and momentum to collision of objects in a clear and consistent manner with a complete and accurate information.	The poem contains the topic about the relationship of impulse and momentum to collision of objects in a clear and consistent manner with an incomplete and somewhat accurate information.	The poem contains the topic about the relationship of impulse and momentum to collision of objects with an incomplete and somewhat accurate information.	The poem contains the topic about the relationship of impulse and momentum to collision of objects with an incomplete and inaccurate information.
Organization	The sequencing of words and phrases is organized, and the reader is able to follow the ordering of ideas easily.	The sequencing of words and phrases is somewhat organized, and the reader is able to follow the ordering of ideas with minimal effort.	The sequencing of words and phrases is quite confusing, and the reader may need to use his or her own knowledge to determine the ordering or ideas.	The sequencing of words and phrases is not organized or very confusing. There is no correct ordering of ideas.
Form and Neatness	The poem contains title, compose of 3 stanzas and neatly presented.	The poem contains title, compose of 2 stanzas and neatly presented.	The poem does not contain a title, compose of only 2 stanzas and minimal neatness	The poem does not contain a title, compose of only 1 or 2 stanzas and messy.

2. Create a picture book or scrapbook on how momentum and impulse is used in sports.

RUBRICS for SCRAPBOOK (#2)

Criteria	Exemplary (5 pts.)	Accomplished (4 pts)	Developing (3 pts)	Beginning (2 pts)
Content	The scrapbook contains information, illustration or pictures about how momentum and impulse is used in 4 different sports.	The scrapbook contains information, illustration or pictures about how momentum and impulse is used in 3 different sports.	The scrapbook contains few information, illustration or pictures about how momentum and impulse is used in 2 sport.	The scrapbook contains less information, illustration or pictures about how momentum and impulse is used in 1 sport.
Creativity, layout and Design	Excellent use of color and design. The output is highly creative.	Better use of color and design. The output is very creative.	Good use of color and design. The output is somewhat creative.	Limited use of color and design. The output is less creative.
Organization and Neatness	Neat and complete. Very well organized.	Almost complete. Nicely organized.	Incomplete. Somewhat organized.	Incomplete and not organized.

3. Make a poster that shows the concepts of relationship of impulse and momentum of collision of objects in a ¼ size white cartolina.

RUBRICS for POSTER MAKING (#3)

Criteria	Exemplary (5 pts.)	Accomplished (4 pts)	Developing (3 pts)	Beginning (2 pts)
Content	Details on the drawing capture the important information about the topic and the audience can fully understand the concept.	Details on the drawing capture some important information about the topic and the audience may not fully understand the concept.	Details on the drawing in incomplete.	Details on the drawing does not contain information about the topic.
Visual Impact	Poster is exceptionally attractive in terms of color and neatness.	Poster is attractive, with color but not so neat.	Poster is less attractive with minimal colors and somewhat messy.	Poster is not attractive at all.
Originality	The poster shows many considerable original works of the student.	The poster shows several considerable original works of the student.	The poster shows few original works of the student.	The poster shows no original work of the student.

- **Momentum** means "mass in motion". It is equal to the product of mass and velocity of an object.

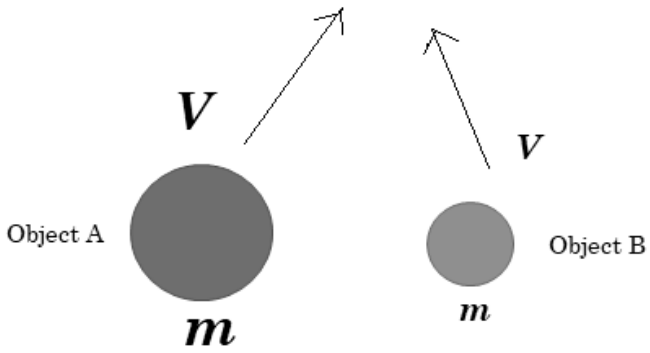
$$p = m \cdot v$$

- If you increase either the mass or the velocity, the momentum of that object increases too.
- If you double the mass or velocity, you also double the momentum.
- An object's change in momentum is equal to impulse.
- **Impulse** is the change in momentum of a moving object.

Assessment

Direction: **Modified True or False**. Write **TRUE** on the space provided before the number if the statement is correct, but if it is false, change the underline word or group of words to make the whole statement true.

_____1. An object which is moving at a constant speed has momentum.
_____2. Two objects of different masses are moving at the same speed; the more massive object will have the greater momentum.
_____3. A less massive object can never have more momentum that a more massive object.
_____4. Two different objects are moving at the same speed. The smaller object is difficult to stop.
_____5. An object with varying speed will have varying momentum.
_____6. Objects involved in collisions encounter impulses.
_____7. Impulse is the force needed to produce a change in the body's momentum through a combination of changes in its mass and/or velocity
_____7. An object which experiences a net impulse will definitely experience a momentum change.
_____8. In a collision, the impulse experienced by an object is not equal to its momentum change.
_____9. Two cars with the same mass collided but having different velocity. Car B travels faster than Car A. Therefore, Car A has greater momentum change than Car B.
_____10. Two objects collide. Object A has greater mass and velocity while Object B has smaller mass and velocity. In this case, Object A has greater change of momentum or impulse.



Answer Key

What I Can Do

(p. 6)

Answers may vary.

What's New

(p. 2)

F	A	T	I	M	E	R	M	A	I
O	D	E	M	H	V	G	A	S	
R	U	Z	P	O	E	L	S	T	
C	A	L	U	P	T	E	S	X	
E	V	E	L	O	C	I	T	Y	
N	O	I	S	I	L	L	O	C	
M	O	M	E	N	T	U	M	N	

What I Have Learned

(p. 5)

A. Multiple Choice
1. a
2. b
3. b
4. a
5. a

B. Modified True or False.
1. True
2. Decreases
3. True
4. has no impulse
5. True

Lesson 1

What I Know (Pretest)

1. T
2. T
3. F
4. T
5. T
6. T
7. T
8. F
9. F
10. T

What's More

						M		
						A		
I	M	P	U	L	S	E		
	O				S			
	M							
V	E	L	O	C	I	T	Y	
	N							
	T							
	U							
	M	O	T	I	O	N		

B.

1. ✓
2. X
3. X
4. ✓

Lesson 2

What's New
(p. 8)

1. the same, the same
2. zero
3. yes
4. yes

What Is It
(p. 8)

1. Yes. Because there is a change in the velocity of the cue ball.
2. Yes. Because there is a change in the velocity of ball number 1.
3. Ball Number 1
4. Ball Number 1

What I Have Learned

1. A
2. B
3. D

What's More
(p. 9)

Situation 1:
a. Car A
b. Car A
c. Car A

Situation 2:
a. Ping-Pong ball
b. Basketball

Situation 3:
a. Marble A
b. Marble A
c. Marble B
Because it has smaller mass and velocity.

What I Can Do
(p. 11)

Answers may vary. Refer to rubrics.

Assessment

1. T
2. T
3. can have
4. larger
5. T
6. T
7. T
8. equal
9. lesser
10. T

References

EASE Module 10: Force and Motion, Lesson 5: Impulse and Momentum, accessed on May 25, 2020.
https://lrmds.deped.gov.ph/detail/6802

For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph * blr.lrpd@deped.gov.ph